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Field Experiments in Spraying for Control of San Jose Scale, 1919

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INTRODUCTION

Lime-sulfur solution has been the insecticide depended upon for a number of years for control of the San Jose scale. Several disadvantages attend the use of this material, chief of which are the losses due to leakage, the liability to freezing, the difficulty of handling by inexperienced workmen, and the expense of shipment.

For several years some of the largest manufacturers of insecticides have put on the market, in dry form, combinations of sulfur and other chemicals, making strong claims for their efficiency in controlling the San Jose scale. Orchardists have been greatly interested in these materials, as shown by the large number of inquiries received concerning them. The present investigation has been undertaken with the object of making a thoro field test of some of the more largely advertised materials. *The data here presented constitute no adequate basis for a recommendation of any of these compounds; they are merely a record of the results of a single season's tests and comparisons.* Further results will be published as obtained.

A number of chemical analyses have been published showing that solutions made with dry materials of the strength recommended by the various manufacturers, do not contain as much sulfur as is generally considered necessary in lime-sulfur solutions for the control of San Jose scale. However, the few field tests reported seem to show that some of them have considerable merit.[1]

[1]Idaho Agr. Exp. Sta. Bul. 108, p. 9. Melander, A. L., Better Fruit, Vol. XIV, No. 1, p. 10. July, 1919.

THE BASIS OF LIME-SULFUR EFFICIENCY

Lime-sulfur solutions as offered by the manufacturers test from 30° to 34° on the Baumé scale, or 1.261 to 1.306 specific gravity, and contain approximately 25 percent of total sulfur. Each gallon of such a concentrated solution contains about 2¾ pounds of sulfur. Previous experiments have shown that a lime-sulfur solution testing 1.03 specific gravity, or 4.3° Baumé, and containing about 30 pounds of sulfur in each one hundred gallons of spray, is the effective minimum for scale control.[1]

Dry lime sulfur is guaranteed by the manufacturers to contain the following substances:

	Percent
Active ingredients	83.0
Calcium polysulfid	70.00
Calcium thiosulfate	5.0
Sulfur	8.0
Inert ingredients	17.0
Total sulfur	49.65

The recommendation for the use of this material is 10 to 14 pounds in fifty gallons of water. Since 49 percent of the material is sulfur, if the higher strength is used, or 28 pounds in one hundred gallons of water, the resulting solution will contain approximately 14 pounds of sulfur—not quite half as much as the generally accepted minimum for the liquid lime sulfur.

DESCRIPTION OF EXPERIMENTS

Duplicate experiments were planned to be conducted independently, the grading to be done at the same date, each experimenter being ignorant of the outline and treatment of the plot being graded.

LOCATION AND CONDITION OF ORCHARD

The orchards selected for the experiments are near Barry, Pike county, and Quincy, Adams county.

The orchard in Pike county is located one and one-half miles west of Barry and contains about forty acres of mature Ben Davis trees. The block selected in the Barry orchard adjoined an Osage hedge which was probably the original source of the scale infestation. The trees nearest the hedge were incrusted and, untreated, would almost certainly have failed to survive the season of 1919. At a distance of two hundred feet from the hedge the infestation was not quite so serious, but many of the limbs were incrusted. The plots were

[1]Ohio Agr. Exp. Sta. Circ. 143, p. 60. Ill. Agr. Exp. Sta. Bul. 180, p. 561; Circ. 180, pp. 20-22. New York (Geneva) Agr. Exp. Sta. Bul. 330. U. S. Dept. Agr. Farmers' Bul. 908, p. 24.

arranged to include each degree of infestation, and were as nearly uniform as possible.

The orchard near Quincy, situated two miles east of the city, on the farm of Wm. Hausemann, consisted of six acres of seventeen-year old trees of mixed varieties, Ben Davis and Grimes predominating. There was a uniformly heavy infestation of scale thruout the orchard, all trees showing some limbs incrusted. The majority of these trees would probably not have survived the season of 1920 if no treatment had been given.

MATERIALS USED

The materials and the strength at which each was used were as follows:

Commercial concentrated lime sulfur 33° Baumé, 1 gallon to 8 gallons of water
Scalecide, 1 gallon to 15 gallons of water
B. T. S., 14 pounds in 50 gallons of water
Niagara soluble sulfur, 12½ pounds in 50 gallons of water
Sherwin-Williams dry lime sulfur, 15 pounds in 50 gallons of water
Dow dry lime sulfur, 15 pounds in 50 gallons of water
Check: unsprayed

TIME AND METHOD OF APPLICATION

Barry Orchard.—The sprays were applied March 28, 1919, with a "Bean" duplex power outfit at a minimum pressure of 250 pounds. There was a brisk west wind which made it necessary to use a spray gun in order to make the application from all sides of the trees. The tops of the trees were covered by a rod, and whirlpool disc nozzles were operated from the tower. The gun was operated from the ground. The weather was warm and the first leaves were beginning to show green. About nine gallons of material was used to each tree.

Quincy Orchard.—The sprays were applied March 27, 1919, with a "Friend" power outfit, using from 250 to 275 pounds' pressure. The tops and upper sides of the branches were sprayed with a gun from the tower, the undersides being covered with a rod used from the ground. A third man stood at a little distance from the sprayer to call attention to any parts of the tree that were missed. In this way, a very thoro application was made to all parts of the trees, about eleven gallons of solution being used per tree.

The weather was warm, with bright sun and a light wind. The leaf buds were just bursting, nearly all of them showing a little green.

RESULTS

The orchards were graded July 21 and 22, by both experimenters, working independently, neither knowing the kind of treatment applied to the plots except in the orchard under his personal supervision. Each tree in a given plot was graded separately, and a general average for the plots was determined. The results were then compared and tabulated as shown in the following table.

SAN JOSE SCALE EXPERIMENTS, 1919

Plot No.	Treatment	Control	
		Barry	Quincy
1	Commercial lime-sulfur solution, 1 gallon to 8 gallons water	Good	Good
2	Niagara soluble sulfur, 12½ pounds to 50 gallons water	Excellent	Excellent
3	B. T. S., 14 pounds to 50 gallons water	Fair	Good
4	Sherwin-Williams dry lime sulfur, 15 pounds to 50 gallons water	Excellent	Excellent
5	Dow dry lime sulfur, 15 pounds to 50 gallons water	(1)	Excellent
6	Scalecide, 1 gallon to 15 gallons water	Excellent	Excellent
7	Check: unsprayed		

[1]Material failed to arrive in time for application.

In the above table the terms used indicate that a plot graded as "Fair" showed a considerable number of live scale present on all parts of the tree and fruit; "Good" indictes scattered living scale, fairly easy to find, but not numerous enough to cause marked blemishes on the fruit or injury to the trees; and "Excellent" indicates living scale difficult to find and no blemishes on the fruit.

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CIRCULAR No. 240

TREATING OATS FOR SMUT

By W. L. BURLISON and R. W. STARK

THE ILLINOIS AGRICULTURAL EXPERIMENT STATION RECOMMENDS THE FOLLOWING TREATMENT FOR THE PREVENTION OF SMUT:

1. Thoroly fan and screen the oats.
2. Mix one pint of formalin with 10 gallons of water for each 80 bushels of seed to be treated.
   Keep this solution covered so as to prevent the formaldehyde gas from escaping.
3. Sprinkle the solution over the oats, using one pint to each bushel, and mix thoroly.
4. Pile the oats up and cover with blankets, canvas, or sacks.
5. After two hours uncover the oats. If they have been thoroly mixed they will have absorbed the moisture so thoroly that they will be dry enough to sow at once in a broadcast seeder or drill.
6. If the oats are not to be seeded at once, they should be spread out in a thin layer and stirred occasionally to allow the escape of the formaldehyde gas.

This recommendation is based on five years' investigations planned to determine a simple, convenient method of treating oats for smut.

TREATING OATS FOR SMUT.

By W. L. BURLISON, Chief in Crop Production, and
R. W. STARK, First Assistant in Crop Production

In 1914, this Station began an experiment to determine the efficiency of very small quantities of formalin solution of varying strengths for controlling smut. It has been a common practice to use as much as a gallon of solution to each bushel of oats treated, but in the conduct of this experiment only one pint of the various solutions was used per bushel. It was found that this amount will thoroly moisten one bushel of oats, making them slightly sticky, but that after they have stood covered for two hours, they will have so fully absorbed the moisture that they may be sown immediately, either with an end-gate seeder or with a grain drill.

The addition of one pint of solution to one bushel of oats adds only approximately 3 percent of moisture. There is therefore little or no danger of heating. However, unless the oats are sown immediately, it is important that they should be aired thoroly in order to allow the escape of the formaldehyde gas, which might otherwise seriously affect the vitality of the seed.

METHOD OF CONDUCTING EXPERIMENT

Seed Used.—Big Four oats known to be seriously infected with smut were purchased at the beginning of the experiment. Thereafter seed was saved from the check plots, which were sown with untreated oats.

Strength of Solutions.—Solutions of formalin (containing approximately 40 percent formaldehyde) of the following strengths were prepared:

1 pint formalin to 3 gallons of water
1 pint formalin to 5 gallons of water
1 pint formalin to 10 gallons of water
1 pint formalin to 20 gallons of water
1 pint formalin to 40 gallons of water

Treatment of Seed.—One-bushel lots of the infected oats were weighed out, and each lot was placed on a square of muslin. To each lot there was applied one pint of one of the above solutions. The oats were then quickly but thoroly stirred, after which the muslin was folded over them and a second one placed on top to hold in the fumes of formaldehyde. After treating for two hours, the oats were uncovered and spread out to air.

Field Work.—The oats were sown in one-tenth acre plots. Duplicate plots were sown of the oats given each treatment. Check plots of untreated oats were placed every third plot in the series. There were four check plots in all.

The investigation was continued for five years. Each year after the oats were fully headed a careful determination of the percentage of smutty heads was made, and at harvest time an accurate record was kept of the yield. These data are given in the accompanying tables.

RESULTS OF EXPERIMENTS

Crop Yields.—Treatment with the 1-3 solution gave the lowest average yield of the treated oats for the five years. Treatment with the 1-5 solution gave a slightly increased average yield and one year (1916) gave the highest yield of any of the treatments. Both

TABLE 1.—YIELD OF BIG FOUR OATS: SMUT-TREATMENT EXPERIMENT. 1914-1918

Strength of formalin solution	Yield in bushels per acre					
	1914	1915	1916	1917	1918	Average
1 pt. to 3 gals. water.....	46.3	58.7	70.3	54.4	51.4	56.2
1 pt. to 5 gals. water.....	51.8	58.9	74.3	50.9	52.5	57.7
1 pt. to 10 gals. water....	52.0	64.3	69.5	54.7	58.2	59.7
1 pt. to 20 gals. water....	50.6	57.8	73.2	56.6	58.0	59.2
1 pt. to 40 gals. water....	48.6	52.6	73.1	60.9	53.5	57.7
Check. No treatment...	42.9	52.1	69.3	51.9	54.5	54.1

these solutions seem to have slightly lowered the vitality of the seed. The seed treated with the 1-10 solution gave the highest yield of oats three out of the five years, and also the highest average yield for the five years. Treatment with the 1-20 solution gave an average yield nearly as high as treatment with the 1-10 solution. The 1-40 solution gave an average yield identical with that of the 1-5 solution, viz., 57.7 bushels per acre. The untreated oats were the least productive, yielding an average of 54.1 bushels per acre, or 5.6 bushels less than those treated with the 1-10 solution.

Percentage of Smut Present.—All of the solutions, except the weakest (1-40), when used at the rate of 1 pint per bushel of oats, practically eliminated the smut. The 1-40 solution permitted the development of an appreciable amount, ranging from 3.5 percent to a trace, or an average for the five years of 1.5 percent. The checks showed a wide range in the number of smutty heads, the range being from 27.3 percent the first year to 1.3 percent the last year of the experiment, with an average of 13.4 percent.

TABLE 2.—PERCENTAGE OF SMUT PRESENT: SMUT-TREATMENT EXPERIMENT, 1914–1918

Strength of formalin solution	Percentage smut					
	1914	1915	1916	1917	1918	Average
1 pt. to 3 gals. water.....	0.0	0.0	0.0	0.0	0.0	0.0
1 pt. to 5 gals. water.....	Trace	0.0	0.0	0.0	0.0	0.0
1 pt. to 10 gals. water....	0.0	0.0	Trace	Trace	0.0	Trace
1 pt. to 20 gals. water....	Trace	Trace	Trace	Trace	Trace	Trace
1 pt. to 40 gals. water....	2.6	3.5	1.5	Trace	Trace	1.5
Check. No treatment...	27.3	22.7	5.1	10.8	1.3	13.4

In another investigation conducted by one of the writers it was found that under controlled laboratory conditions, where the full effect of the formaldehyde was obtained, solutions of any of the strengths used in the above experiment, applied at the rate of 1 pint per bushel, are effective in killing all smut spores. These laboratory experiments also indicated that the fungicidal action of formaldehyde as well as its effect upon the viability of the oats depends upon the actual amount of the formaldehyde gas applied per bushel of oats rather than upon the amount of solution used. One pint of a 1-10 solution of formalin contains approximately .005 of a pound of formaldehyde gas.

SUMMARY

Under the condition of this experiment conducted for a period of five years, a solution of 1 pint of formalin, containing 40 percent formaldehyde, mixed with 10 gallons of water contained the most satisfactory amount of formaldehyde when used at the rate of 1 pint of solution per bushel of oats. This strength of solution permitted the development of a trace of smut two years out of the five, but this amount was insignificant and the average yield of oats was the greatest obtained in the series.

RECOMMENDATION

The above figures seem to clearly justify the Illinois Experiment Station in recommending the following treatment for the prevention of smut:

Mix one pint of formalin (40 percent formaldehyde) with 10 gallons of water. Use one pint of this solution per bushel of oats treated. Sprinkle this evenly over the oats and thoroly but quickly mix until every grain is slightly moistened. Cover at once with a blanket, canvas, or sacks. Allow the oats to remain covered for two hours, after which time uncover. If the oats are not sown at once, thoroly air to allow the formaldehyde gas to escape.